

INTERNATIONAL CITY MANAGERS' ASSOCIATION  
1313 EAST 60TH STREET - CHICAGO 37, ILLINOIS

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### MASS PRODUCTION DUPLICATING METHODS

What duplicating methods are available? How much do they cost? When should they be used? How can a duplicating service be organized?

Because of the high cost of letterpress printing the officials of many cities are looking for low-cost methods of reproducing reports, leaflets, record forms, and other materials that are not printed in large quantities. Duplicating methods permit the use of pictures, colors, different type faces, and a variety of paper stock--all that were once the features only of the printing press. Some of the cities that are using these duplicating methods are bringing them together under one department, setting up what might be called a "central duplicating service", in order to obtain lower operating costs and the advantages of specialized skills.

Four mass production duplicating methods are available to city officials. They are: stencil (mimeograph), hectograph (both fluid and gelatin processes), relief duplicating, and offset duplicating. Of the four, the stencil process is the best known and is perhaps the most used in city halls. All of these processes employ a machine using a revolving cylinder, turned either by hand or electrically, into which the paper is fed by hand or automatically. The machines range from small table models up to machines as large as medium-size printing presses.

Other duplicating methods are also available, but they are not mass production processes. There are a number of photographic processes such as photostat, blue printing, Ozalid, such machines as Portagraph, its larger brother the Dextigraph, the Rectigraph, and others as well that reproduce copy many different ways, but none of these processes or machines offer anything like mass production. Microphotography or microfilming also is a method of reproduction but largely to conserve space taken up by stored records and to protect irreplaceable documents. Yet microfilming is one of the cheapest methods of duplicating if only a few copies are to be made of a large number of items that are in sequence, such as the pages of a book, court hearings, and council proceedings.

Stencil Process. In the mimeograph or stencil process the material to be reproduced is typed or traced on a wax stencil. The stencil is then placed on a revolving ink-filled cylinder and turned electrically or by hand. Using a fast-drying ink this process reproduces a fade-proof image on a variety of paper and card stock. Paper with hard finishes cannot be used unless careful precautions are taken to prevent smudging until the ink dries. Ordinarily black ink is used although vivid colors are possible. The stencils may be preserved for repeated running. A carefully prepared stencil will yield under optimum conditions up to 10,000 copies and a modern electric machine will produce copies almost as fast as a printing press. A variety of stencils are available for use with the mimeograph. A photographic stencil is also available for fine line work, sketches, and long runs. Among the business concerns selling stencil duplicating machines are A. B. Dick Company, Heyer Corporation, Marr Duplicator Company, Inc., and Niagara Duplicator Company.

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Hectograph Process. The hectograph process uses two techniques--the fluid method (spirit) or the gelatin method; the former is the more recently developed and also the more popular. Under the spirit process the information is typed or traced on a master sheet behind which is a hectograph carbon paper that produces a reverse carbon image on the back side of the master sheet. The master sheet is then placed on the rotary cylinder. With the gelatin process the image on the master sheet is transferred to a gelatin sheet and then to the paper. Gelatin films for rotary models are fastened to the drum of the machine.

The hectograph process by the spirit method will produce up to 300 copies (perhaps more) and by the gelatin method probably not over 60 copies. Red, green, purple, and blue colors can be printed simultaneously and also a black-gray color. Colors are obtained by inserting different carbon sheets one at a time in back of the master during typing or tracing. Only a nonabsorbent paper with a hard shiny surface can be used with this process. Copies produced by the liquid method are more permanent since the liquid practically dyes the ink into the fibres of the paper while the gelatin merely deposits the dye on the surface of the paper. In any case the impression is subject to fading if continually exposed to light.

One example of the usefulness of the hectograph is illustrated by the flat-bed gelatin duplicator sold by Ditto, Inc., which is especially useful for duplicating terrain maps, weather maps, and engineering drawings. Model 18 F5 (Ditto, Inc.), for example, reproduces on a sheet any size up to 18 inches by 34 inches with a copying surface of 17 3/4 x 32 1/2 inches. Among the companies supplying hectograph duplicators are Ditto, Inc., Standard Duplicating Machines Corporation, Rex-O-Graph, Inc., Duplicator Corporation, Duplicopy Company, and Wolber Duplicator and Supply Company.

Relief Process. The relief duplicating process is a simple application of the printing press using a cylinder on which removable frames of type or electroplates are fastened. No stencils or special masters are employed. Type slugs, linotype, monotype, or rubber plates are embossed on circular frames, which are mounted on the revolving cylinder by sliding them into grooves. The Multigraph or the Davidson relief process machine will produce copy having an appearance comparable to that obtained by the larger printing presses.

This process is particularly useful for long runs, producing exact copies of typewritten letters, imprinting on other printed materials, printing envelopes, cardboard, and other materials. The type is obtainable in a variety of sizes and faces, and typesetting machines may be purchased. As in the case of typewriting the right-hand margins come out uneven unless justified by hand or with special adjustable spaces. The type can be held for re-runs; otherwise it must be scrapped. The relief process allows the use of a greater variety of paper stock than any other duplicating method. Two companies manufacturing and selling machines using this process are Addressograph-Multigraph Corporation and the Davidson Manufacturing Corporation.

Offset Process. The offset duplicating method overlaps the stencil and photographic processes. Like the stencil process the information can be typed or traced on paper or aluminum masters or it can be photographed on to a zinc plate. Unlike the stencil or hectograph processes, the image is not printed directly from the master to the paper but from the master to a cylindrical blanket and from that on to paper.

The offset process will print either in ink or in the primary colors. The impression obtained is a soft effect that ordinarily does not smudge. Paper



ranging from 3 x 5 inches up to 11 x 14 inches can be fed through the machines, varying in weights from 13-pound substance up to 3-ply bristol. Reproduction speed ranges from 3,000 to 6,000 copies per hour with quantities from 300 to 30,000 obtainable depending on the particular plate used. The paper and aluminum plates can be typed on, written on, or drawn on, with pen, pencil, or other writing substance. The zinc plate is used for photographic purposes. Companies selling the machines as well as commercial plate making plants will prepare the photographic plate. The Addressograph-Multigraph Corporation and the Davidson Manufacturing Corporation sell offset duplicating machines. The Davidson Manufacturing Corporation also sells the Dual Duplicator that is both an offset and a relief duplicating machine.

What the Equipment Costs. Cities can spend from just under \$100 up to several thousand dollars for duplicating equipment. As a rule the costlier machines are more versatile, permit the use of a greater variety of paper, offer large production volumes at low costs, produce a print-like copy, and in some cases offer larger printing areas. Equipment prices usually do not include the accessories and extras needed to operate the machines. The lower-priced models usually require hand-feeding of the paper with a machine-feed device an accessory available at extra cost. Special cabinets, stands, and the like are not usually needed to operate these machines. Before buying any particular model, city officials should ask for a demonstration, and also learn the opinions of other users of the various types of duplicating equipment. (For example, the cities with central duplicating plants are listed in Public Management, June, 1949, p.171).

The prices quoted below are generally FOB Chicago, except in the cases of the Wolber Duplicating and Supply Company and the Addressograph-Multigraph Corporation whose prices are FOB Milwaukee, and FOB Cleveland respectively. These prices exclude all taxes unless otherwise noted and also exclude any accessories or extras unless they are parts of a higher priced standard model. Whenever there is a price range for either hand- or electrically-powered machines, lower prices cover hand-feed machines, the higher prices the automatic feed machines. The A. B. Dick Company sells its equipment through licensed distributors at prices ranging from \$175 to \$385 for hand-operated machines and \$495 to \$935 for electrically-run machines. Hectograph machines (fluid process) range from \$147 up to \$700 with some of the gelatin process equipment costing as much as \$1,075. Ditto, Inc. sells hand-operated hectographs (fluid process) from \$200 up to \$495, and electric machines from \$475 up to \$625. The Ditto, Inc. gelatin-process machines cost from \$85 to \$1,075 with the electric machines starting at \$325.

The Standard Duplicating Machines Corporation sells 12 hand-operated models costing from \$200 up to \$460, and 10 electric models priced from \$460 to \$690. Prices of the electric models include the cabinet. Rex-O-Graph, Inc., sells hand-operated machines from \$89 to \$225, and electric machines from \$320 to upwards of \$595. The Wolber Duplicator and Supply Company sells its Copy-rite machines from \$175 to \$220 for hand-turned machines and \$369 for an electric duplicator. The Duplicopy Company sells two hand-operated models, one a hand-feed machine for \$195, the other an automatic paper feed machine for \$225. Duplicopy prices include federal taxes. All these machines--Standard, Rex-O-Graph, Wolber and Duplicopy--are fluid process hectographs.

All of the offset and relief process machines except one are electrically operated although the low-priced models are hand-fed machines. The Addressograph-Multigraph Corporation sells four models of offset process machines (Multilith): model 50 for \$550 to \$700, model 75 for \$1,155, model 1250 for approximately



\$2,100, and model 2066 for \$3,750. Model 75 is the newest machine brought out by the Addressograph-Multigraph Corporation, to compete more directly with the mimeograph process. The Addressograph-Multigraph Corporation sells five models of relief process machines (Multigraph): model 100, the hand-operated machine, at \$175 to \$275 depending on extras, model 240 at \$895, model 250 at \$1,595, model 379 at \$1,795, model 479 at \$2,225. A multigraph typesetter, a steel frame holding one of 13 styles of type, both upper and lower case, costs \$60 which includes the type as well.

The Davidson Manufacturing Corporation sells its two low-priced models #209 and #210 for \$750 and \$920 respectively, the latter machine having both continuous and intermittent speeds. Its model 221, which prints on paper up to 10 x 14 inches, is offered in three styles: (1) the Dual Duplicator, which is a combination offset-relief machine, at \$1,899; (2) the offset machine only at \$1,792; and (3) the relief machine only for \$1,605. Davidson also has a model 223 of two types, (1) a Dual Duplicator priced at \$2,049 and (2) a relief machine only costing \$1,755, both of these machines accepting paper as large as 10 x 22 inches.

Operating Costs. The purchase price is only the beginning. The city then starts buying extras and necessary supplies to operate the machine. As a rule the more complex processes require the greater number of supplies and accessories. Operating costs which include labor time, machine repair and maintenance, as well as supplies, must be carefully watched to keep them within reasonable bounds.

Some indication of operating costs can be obtained from the maintenance costs and prices charged by central duplicating services. The Berkeley, Calif., duplicating service estimates that its model 1250 offset machine will cost \$1,370 to maintain over its ten-year estimated life. The maintenance cost plus the initial outlay of \$2,685 totals approximately \$4,055 to be paid for by a 65 cent per hour charge. Thus other city departments in Berkeley would pay 65 cents per hour for offset work plus 15 cents per 1,000 sheets run for ink, water, electricity, chemicals and miscellaneous items, plus labor time and paper costs. Paper was charged at cost plus a 10 per cent markup. Photographic plates for use with the Multilith cost \$3.15 plus postage for a single 8 1/2 x 11-inch form. Some cities have their own plate making equipment; Greensboro, N. C., buys the photographic negative for \$1.70 and then makes its own zinc plate.

The Kansas City, Mo., duplicating section makes the following charges for offset work on its model 1250: 75 cents for makeready, 12 cents for ink and chemicals, \$1 per 1,000 impressions, plus 20 per cent of these costs for overhead, plus the cost of the master. On model 2066 the charges are \$1.25 for makeready, 17 cents for ink and chemicals, \$1.25 per 1,000 impressions, plus 20 per cent for overhead, plus the cost of the master. The service department charges in Public Administration Clearing House (1313 East 60th Street, Chicago) illustrate to some extent the comparative costs of the various processes. A brief comparison of running costs shows that 100 copies on one side of an 8 1/2 x 11-inch sheet by mimeograph costs 70 cents, only 2 cents more than 100 copies by hectograph. In short, these are running costs only, for they do not include the cost of the stencil or master, typing and proofreading costs. Again if the stencils are furnished ready to run, 500 copies by mimeograph cost \$1.50 and by the offset process \$2. Except that in the case of the offset process, it costs another 25 cents to clean and file the masters. Mimeographing and hectographing charges include labor time, repairs and maintenance as well as depreciation



on the equipment, certain indirect costs such as supervision, telephone, etc., but not rent, electricity or water. The offset charges are preliminary and were obtained by reducing somewhat the charges of local commercial services, eliminating profits and taxes.

Which Process to Use. The duplicating process to employ depends a good deal on the job to be done. Some of the criteria for deciding on the particular process include speed, capacity, appearance, colors, size of printing area, and ability to perform difficult work, and costs. No one machine can be considered the best on all of these requirements. Some general principles can be outlined that might serve as guides. If from 6 to 300 copies are needed, if appearance is secondary, if the report need not last a long time, and particularly if speed is necessary--speed from the time the copy is given to a typist to the finished product--then the hectograph (fluid process) is the answer. The hectograph requires the least amount of makeready time, practically none, and offers sharp, clear copies in at least four colors. All the other duplicators require changing the ink in the machines in order to use more than one color unless of course more than one duplicating machine is used.

If fade-proof copies are required and more than 25 copies are to be run, then the mimeograph is the cheapest, requiring after the hectograph the least amount of makeready time. Large volumes can be produced by a mimeograph machine, using a completely automatic machine, with impressions produced as fast as the printing press. To some extent the smaller offset machine with the paper master is competing with the mimeograph in providing relatively fast set-up and run-off time at low cost. Although both the mimeograph stencil and the offset paper master can be filed for re-use, the latter can produce only 1,000 copies and must be coated with a preservative. The offset aluminum master, slightly more expensive than the paper master but usable on both sides, can produce up to 10,000 copies. But the aluminum master requires a bit more preliminary preparation before copy can be run off.

As the need for haste diminishes and as the demand for finer appearance increases, then the offset process using the aluminum or zinc plates, or the relief process using type or rubber plates, provides the answer. Print-like copy can be obtained from these machines and a great variety of paper stock can be used. Makeready time adds up in using the photographic (zinc), type, or rubber plates, especially where commercial plate makers are used. Large-volume runs can be made with offset and relief process machines, while half-tones, drawings, fine-line forms, and other difficult work can be reproduced. Masters can be filed away for re-use, permitting small runs at a time, reducing the need for large inventories since the master can be brought out and run over. Letterheads, accounting forms, purchase orders, personnel records, cost records, accident forms, and other types of public records can be set up on photographic plates or type plates to be run off and filed away.

Cities owning a Davidson Dual Duplicator or separate relief and offset duplicating machines can select the process best suited for a particular job. Hartford, Conn., for example, employs the relief process to print letterheads, using a rubber mat for the main part of the letterhead with small detachable rubber mats for the name and address of each city department. For this type of work an offset machine would need a separate master for each department. On the other hand, the offset machine is selected to reproduce forms and the like because the cost of making the master or plate is less than that for relief process.

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Central Duplicating Service. Just as cities have established central accounting, purchasing, and other housekeeping services, so are they setting up central duplicating services. A central duplicating service "prints" the forms, letters, reports, ordinances, bulletins that are issued in quantity by a municipality. The duplicating service may consist of one mimeograph or a battery of offset process machines. It may be run on a part-time basis, or by a full-time crew of specially trained employees.

A central duplicating service offers a number of advantages, principally lower costs of reproduction with almost print-like quality of work, and also the possibility of tighter management control over the city's forms, records, and printed work generally. Such a service permits speedy reproduction of rush jobs without interference from other customers served by a commercial printer, and in many cities it eliminates the chore of soliciting bids for most of the city's printing work. Savings of from 10 to 30 per cent of the printing bill were indicated by 13 cities whose duplicating services are described in Public Management, June, 1949, p. 171.

The central duplicating service probably should be managed by a chief staff officer such as the finance director, the city clerk, or the purchasing agent. If the volume of work justifies full-time machine operators, then the city can reap the advantages of specialized skills. The service can be financed through a revolving fund established by a loan from the general fund or through a clearing account within the general fund. In either case the special fund or the clearing account would pay shop expenses as well as receive payments for duplicating work done for the several city departments.

A central duplicating service probably could be established for \$2,500 to \$3,500. To achieve any sort of variety of print work an offset or relief process machine is desirable. A \$3,500 duplicating service might include an \$1,100 offset machine, a \$400 hectograph, a \$600 electric typewriter, a \$900 varityper, and \$500 for miscellaneous items. Difficult paper trimming, stapling, binding work would require still additional equipment. Hartford, Conn., has a \$5,000 duplicating service that includes a mimeograph, a Davidson Dual Duplicator, paper cutter, electric typewriter, varityper, and mechanical collator.

A municipality may hesitate to pay \$1,000 or \$2,000 for a duplicating machine, preferring instead the less costly mimeograph or hectograph. But the offset or relief process machines can be used for a greater variety of jobs and yield results comparable to printing. For example, a small city may not install an administrative reporting system form or a new set of accounting records because too large a supply must be purchased from a printer to make the cost worth-while. Once the offset or type plate is prepared, it can be used to run as many copies as are necessary and then filed away for later use. As a result large inventories are unnecessary.

A schedule of rates should be prepared for the more common duplicating work so the using departments can calculate costs beforehand and for the annual budget. Labor rates should be specified so that special jobs for which complete rates cannot be established because of their infrequency or peculiarity, may have their costs calculated roughly. The rates should include labor time on the machines, repairs and maintenance of the equipment, as well as depreciation. Indirect costs ought to be taken into account as well. It would be desirable to set up a replacement fund, as is recommended for automotive equipment in MIS Report No. 64 so that the equipment earnings will gradually build up a fund to pay for the replacement of obsolete equipment.



Basis for Rules for Central Duplicating Service. Rules are needed to expedite the flow of work through the duplicating service and also to provide an orderly method of filing stencils, plates, masters, and other records of printed work. The following can serve as a basis for rules to guide operations in the central duplicating service.

1. All printing or duplicating work whether done by the duplicating section, commercial printers, or on a city department's own duplicating equipment, should be referred to the duplicating service for approval and assignment of a form number.

2. Requisitions for duplicating service might originate with any supervisory city employee. The requisition form could show the following information: name of requisitioning department, date, account code to be charged, quantity, form number and title of form to be duplicated. Detailed instructions for each job, such as padding, punching, perforating, numbering, indication of paper size, quality, color, and etc. should be given on the form. Whenever an existing form is to be changed or a new form introduced, a typewritten or lettered sample should accompany the requisition.

3. Requisitions for printing work to be done outside the duplicating service would still be sent to the purchasing agent. If the city intends to maintain a master file of printed forms, then the purchasing agent should forward the requisition to the duplicating service where a form number will be assigned. Any work that has been done or can be done by the duplicating service should not be sent outside to commercial printers without the approval of the city manager.

4. A master file of all printed forms should be kept by the duplicating service. The file would be of three parts, (1) a card file of forms in use, one card for each form, to carry the name of the department ordering and using the form, the description of the form, and the form number. Each re-order would be entered on this record showing the date, quantity ordered, requisition number, and the date of delivery of those forms printed in the duplicating section. Supplementing this card file would be (2) a complete file of the actual forms and letters themselves, indexed by department and form number, and (3) a file of the stencils, plates, and negatives used in the duplicating section, also indexed by department and form number.

5. All printed material whether reproduced by the city or by commercial printers should be approved by the city manager's office.

6. The rules should contain a priority schedule to prevent work jams in the duplicating service. For example, one rule might state that all requisitions should reach the duplicating service at least 30 days before the desired date of delivery. Some exceptions must be made to this rule; for example, high priority jobs of a recurring nature such as ordinances, the annual budget, and monthly financial reports. There will also be high priority jobs of a nonrecurring nature such as special reports. The priority for all such work should be established by the city manager's office. Furthermore, there will be small jobs for which the requisitioning department prepares the stencils, masters, or plates. These very likely can be printed within one or two days after receipt of the approved copy by the duplicating service.

7. City employees bringing work to the duplicating shop should not be allowed to wander around, interrupting the employees at their work. A front desk should receive the orders, answer questions, assign delivery dates, and return completed work.



